June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

Filed Jan. 16, 1962 6 Sheets-Sheet 1

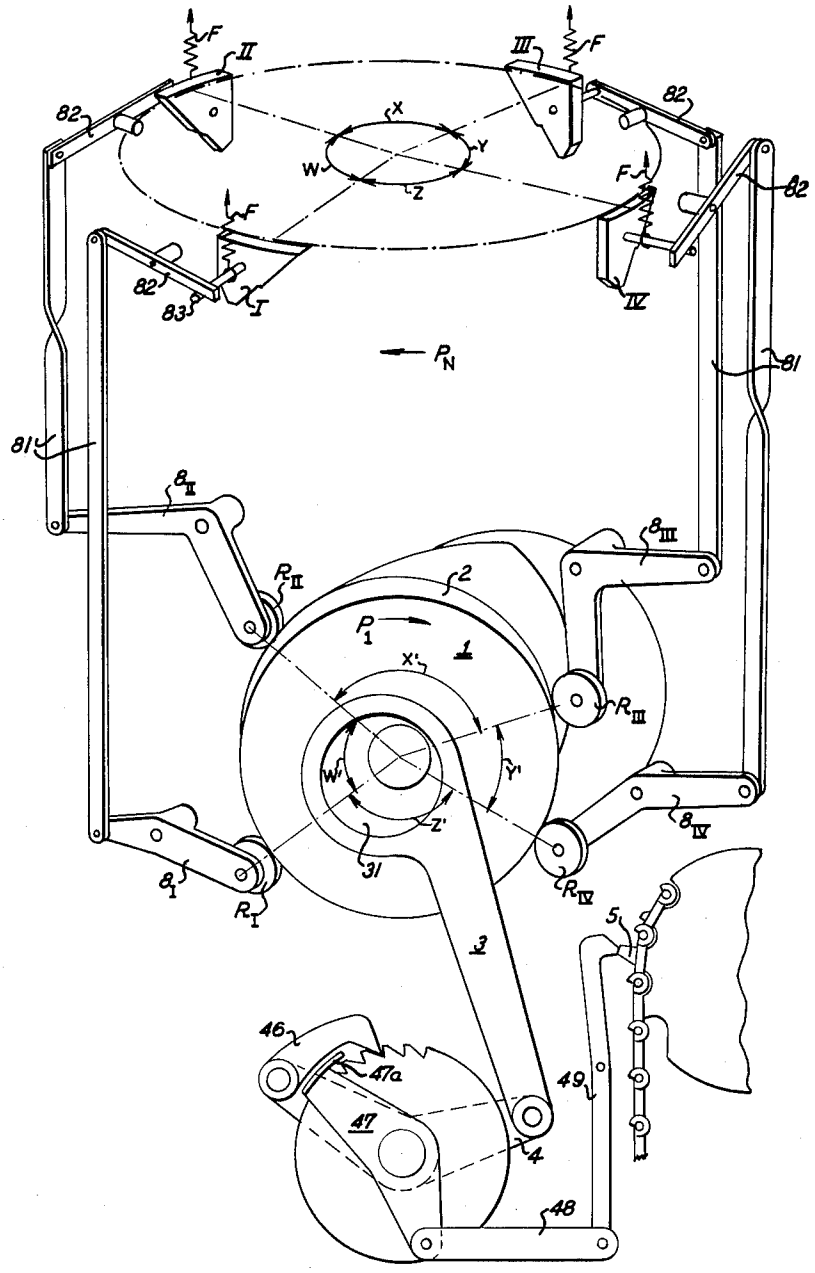


Fig. 1

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June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

Filed Jan. 16, 1962 6 Sheets-Sheet 2

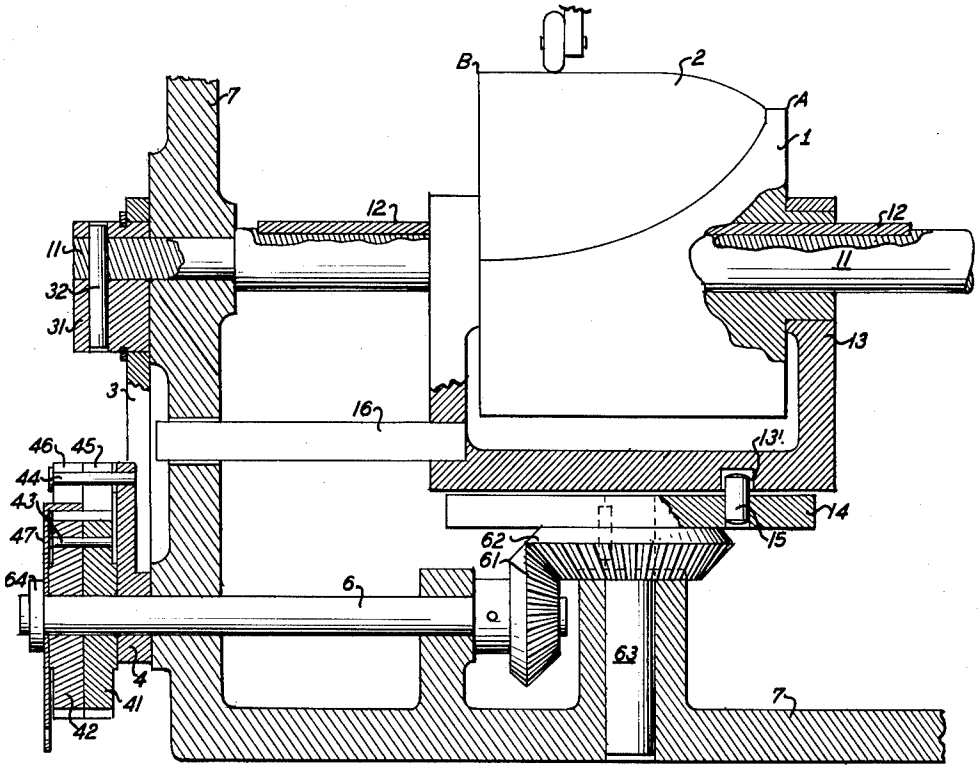


Fig. 2

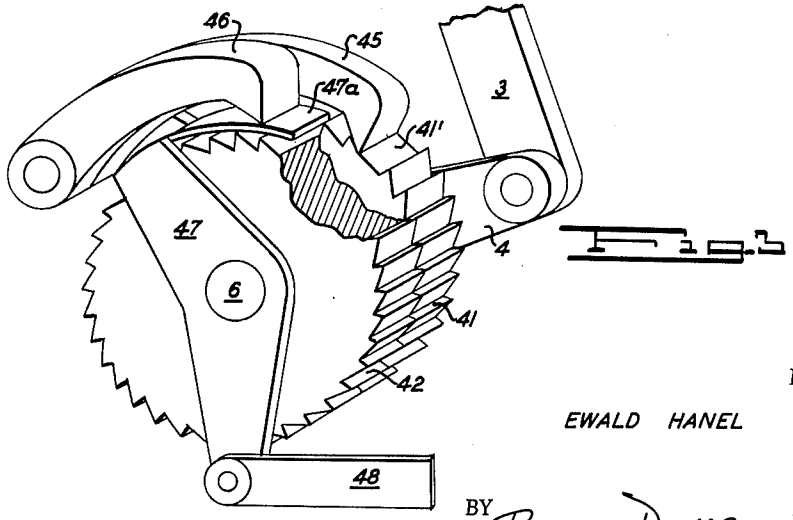


Fig. 3

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June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

Filed Jan. 16, 1962 6 Sheets-Sheet 3

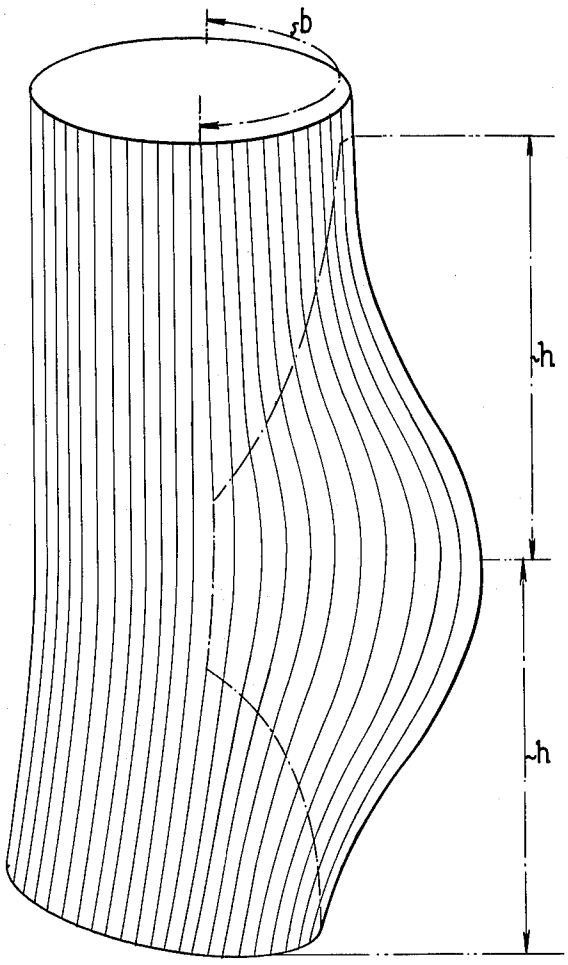


Fig. 4

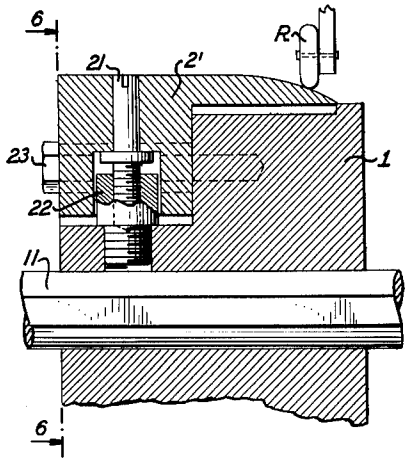


Fig. 5

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June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

Filed Jan. 16, 1962 6 Sheets-Sheet 4

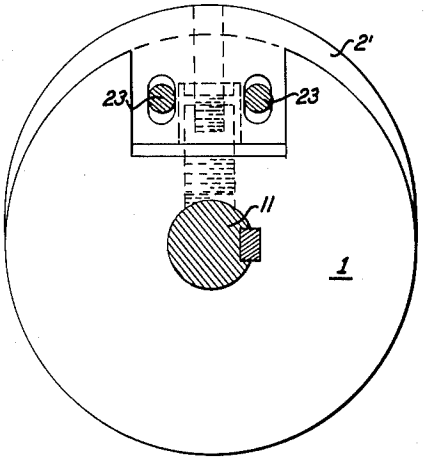


Fig. 6

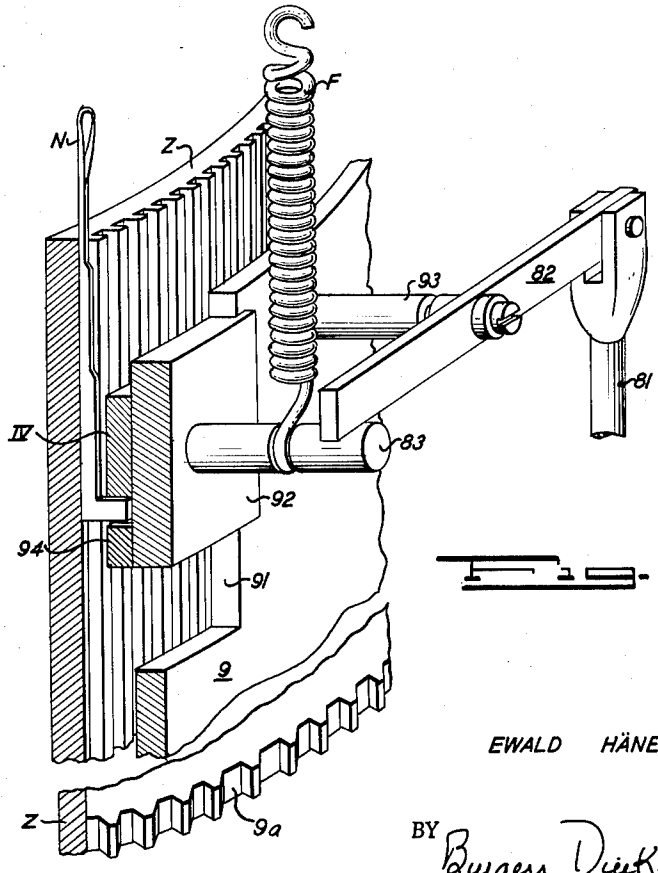


Fig. 9

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June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

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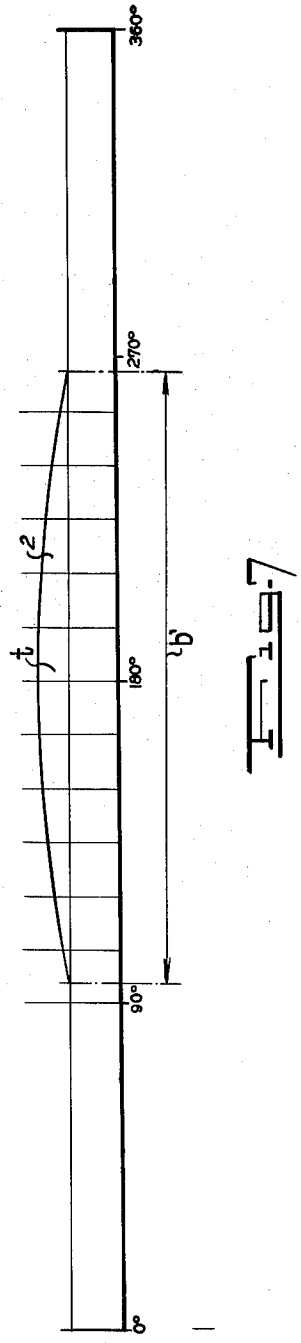


Fig. 7

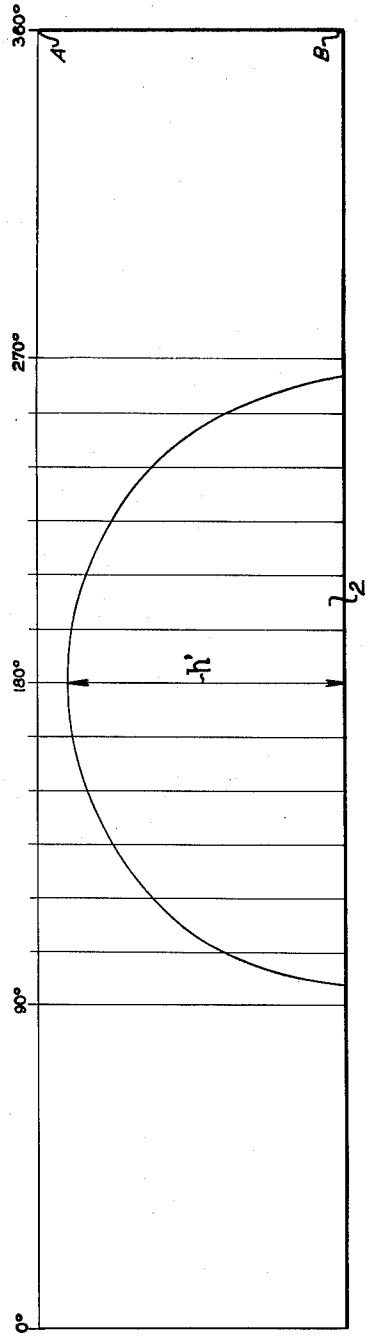


Fig. 8

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June 21, 1966 E. HÄNEL 3,256,716

CIRCULAR KNITTING MACHINE

Filed Jan. 16, 1962 6 Sheets-Sheet 6

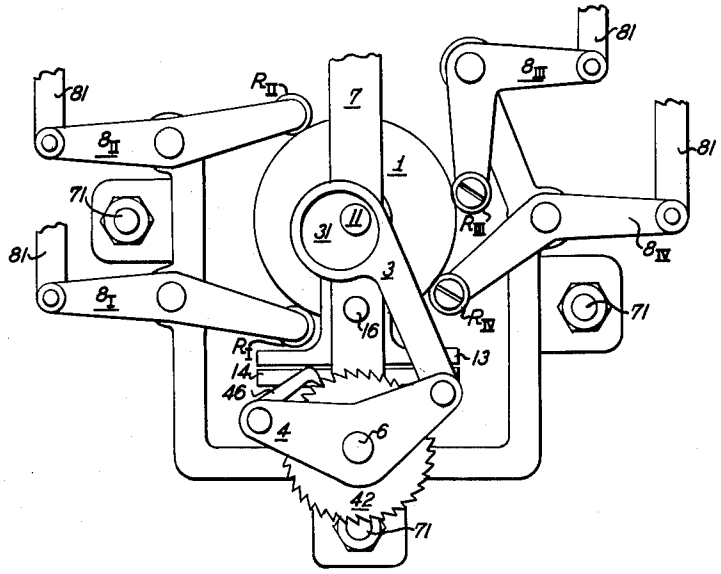


Fig. 10

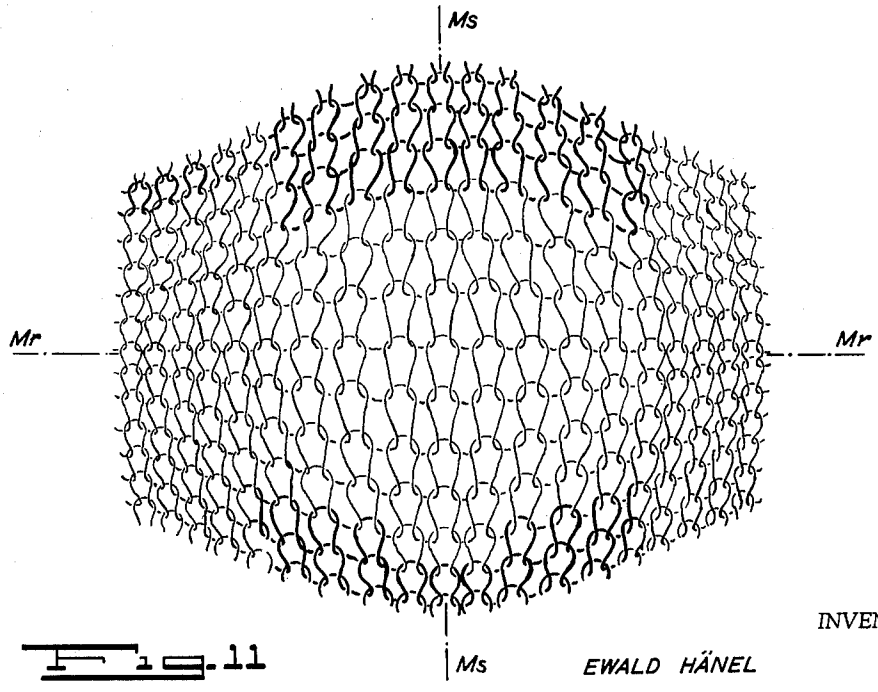


Fig. 11

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United States Patent Office 3,256,716 Patented June 21, 1966

3,256,716

CIRCULAR KNITTING MACHINE

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Filed Jan. 16, 1962, Ser. No. 166,615
Claims priority, application Germany, Mar. 10, 1961, Sch 29,370
16 Claims. (Cl. 66—54)

This invention relates to a circular knitting machine and to a process for knitting heel and toe pouches in hosiery.

In the manufacture of hoisiery, it is usual to form a pouch at the heel and a closure or pouch at the toe. In one known method for knitting the heel and toe pouch, a rotating cylinder of a circular knitting machine is subjected to a reciprocating motion in which only a portion of the needles perform the knitting. This method necessarily involves some reduction in the production rate and also presents difficulties during the reciprocating motion of the cylinder when knitting with several yarn feeds.

In another known method, such as disclosed in U.S. Patent No. 2,825,215, issued March 4, 1958, to John C. Buckreus, the stocking is knitted in a knitting machine in the shape of a tube and the heel bulge is formed in the tube after the tube has been removed from the knitting machine by setting the shape of the heel while the heel portion is in a plasticized condition. This method is not completely satisfactory in that it stretches the yarn and does not always provide a well fitting heel.

Another method of making the heel and toe pouches is disclosed in British Patent No. 756,841 as well as U.S. application Serial No. 114,513, filed June 2, 1961 now U.S. Patent No. 3,192,741, wherein additional courses are added to the circumferential portion of the stocking so that the heel and toe pouches contain more courses than the instep of the stocking.

It is the general object of the present invention to avoid and overcome the foregoing and other difficulties of, and objections to, prior art practices by the provision of an improved method and device to produce the heel and toe pouches on a continuously rotating circular knitting machine employing several yarn feeds.

The improved method of the present invention consists of forming a heel or toe pouch by progressively increasing or decreasing the size of the loops formed in a knitting machine. To form a heel pouch, the size of the loops is progressively increased both in a longitudinal and circumferential direction and then decreased in size also in a longitudinal and circumferential direction. The change in size of the loops is achieved by selectively drawing the knitting needles deeper on the needle cylinder to draw the yarn into larger loops and by shortening the draw of the needles to decrease the size of the loops. The position of the stitch cams which actuate the needles for knitting the heel and toe pouches is changed by means of a control cam which actuates cam followers operably connected to the stitch cams.

Accordingly, it is an object of the present invention to provide an improved method for knitting hosiery by varying the size of the loops used to form the heel and toe pouches.

Another object of the present invention is to provide an improved knitting machine having a movable stitch cam for knitting heel and toe pouches.

Still another object of the present invention is to provide an attachment to a knitting machine for knitting heel and toe pouches.

Other objects and features of the present invention will appear as the description of the particular physical embodiment selected to illustrate the invention progresses. For a better understanding of the present invention reference should be had to the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a partial schematic view of a circular knitting machine having four feeds and showing the improved means of the present invention for knitting heel and toe pouches;

FIG. 2 is a sectional side elevation of the control cam and the means for axially shifting the control cam;

FIG. 3 is a detailed perspective view of the ratchet wheels used for axially shifting the control cam;

FIG. 4 is a partial side view of a stocking having a heel pouch knitted according to this invention;

FIG. 5 is an alternate embodiment of the control cam showing the cam surface member detachably and adjustably connected to the control cam;

FIG. 6 is an elevation of the control cam shown in FIG. 5 taken along the line 6—6;

FIG. 7 is an elevation of the development of the control cam;

FIG. 8 is a plan view of the development of the control cam;

FIG. 9 is a perspective view of one of the stitch cams and associated parts;

FIG. 10 is an elevation of the control cam and associated parts shown in FIG. 2; and

FIG. 11 is a schematic view of the loops of a heel pouch in a stocking produced according to this invention.

The present invention will be described in connection with a four feed circular knitting machine; however, it is to be understood that the invention may be used in connection with a circular knitting machine having any number of feeds.

With specific reference to the form of the present invention illustrated in the drawings and referring particularly to FIGS. 1 and 9, a plurality of stitch cams I, II, III and IV are disposed about the periphery of a needle cylinder of a circular knitting machine. The needle cylinder is outfitted with gearing 9*a* for the driving thereof. The stitch cams are adapted to actuate the needles N which are disposed in slots at the outer periphery of the needle cylinder Z as shown in FIG. 9. The stitch cams are slidably mounted in a cam ring 9 extending around the periphery of the needle cylinder and means are provided for moving the cams vertically to vary the position of the needles N within the needle cylinder slots. Thus by lowering the stitch cams, the needles N are selectively moved to a lower position to form larger loops in the heel and toe pouches of the hosiery.

The means for lowering the stitch cams I, II, III and IV consist of a system of rods and levers movable in response to a control cam 1 as shown in FIG. 1. For the purposes of this description the operation of the stitch cam IV will be described in detail although it is to be understood that the stitch cams I, II and III operate in the same manner.

As can be seen in FIG. 9 a stationary cam ring 9, which extends around the periphery of the needle cylinder Z, is provided with an opening 91 which serves as a guide for the vertically movable cam carrier 92. Attached for vertical movement with the cam carrier 92 is the stitch cam IV which is operable to engage the butts of the needles to displace the needles longitudinally within the slots of the needle cylinder. The cam carrier 92 also carries a guide cam 94 to provide a guide for the underside of the needle butts as the needle butts travel past the cam surface.

The cam carrier 92 is biased in an upward position by a spring F which engages a pin 83 extending laterally from the cam guide 92. In order to lower the cam carrier 92 against the spring bias, a pivotal lever 82 is provided to

engage the pin 83 and lower the cam carrier 92 within the opening 91. The lever 82 is pivoted about a pin 93 extending from the cam ring 9 by means of a thrust rod 81 hinged to one end of the pivotal lever 82. The thrust rod 81 is actuated by the control cam 1 by means of bell crank levers 8I, 8II, 8III and 8IV. Each of these bell crank levers 8 carries a cam follower or roller RI, RII, RIII and RIV operable to engage the cam 1.

The bell crank levers 8 are disposed around the cam 1 in the same relative angular relationship as are the stitch cams I, II, III and IV disposed around the needle cylinder Z. Thus the angles *w*, *x*, *y* and *z* between the stitch cams I, II, III and IV on the needle cylinder are equal to the angles *w'*, *x'*, *y'* and *z'* between the cam followers RI, RII, RIII and RIV on the cam 1 so that the action commenced by the cam 1 becomes successively effective on all the stitch cams at the same place on the cylinder. Thus if the needles starting at one point of the cylinder are made to draw increasingly deeper by the stitch cam I, then the subsequent stitch cams II, III and IV will likewise run the same needles increasingly deeper from the same point on the cylinder.

The cam 1 is carried on a shaft 11 which is assembled on a housing 7 to form an independent unit which can be used as an attachment on circular knitting machines having adjustable stitch cams. The housing 7 is attached to the circular knitting machine frame by the bolts 71 shown in FIG. 10.

A cam surface 2 may be formed integral with the cam 1 or it may be detachably and adjustably connected to the cam 1 as shown in FIGS. 5 and 6. In these two drawings a cam surface member 2' is held to the cam 1 by holding bolts 23 threaded in the cam 1. In order to raise or lower the position of the cam surface member 2' on the cam 1, a screw 21 threaded into a bushing 22 is provided. By loosening the holding bolts 23 and turning the screw 21 in the bushing 22, the cam surface member 2' may be raised or lowered into any desired position. Once the desired position is set by the screw 21, the bolts 23 may be tightened to secure the cam surface member 2' in position.

A mechanical connection between the needle cylinder drive and the shaft 11 is operable to rotate the cam 1 one revolution in the direction indicated by the arrow P_1 for every one revolution of the needle cylinder in the direction indicated by the arrow P_N (FIG. 1). As the needle cylinder and the cam rotate, the cam surface 2 engages the cam followers R to change the position of the stitch cams in the openings 91 of the cam ring 9.

As can be seen in FIG. 2, the cam 1 is longitudinally movable on the shaft 11 and is adapted for rotation with the shaft 11 by a key 12. A fork type cage 13 is mounted about the cam 1 in order to provide means for sliding the cam 1 on the shaft 11. This cage 13 is prevented from rotating with the cam 1 by a pin 16 extending between the frame 7 and the cage 13. The cage 13 is moved longitudinally of the shaft 11 by means of a crank wheel 14 which carries a crank pin 15 adapted to engage a groove 13' in the cage 13 so that rotation of the crank wheel 14 will displace cage 13 and cam 1 longitudinally of the shaft 11. Crank wheel 14 and a bevel wheel 62 are keyed to a common shaft 63 and these two wheels are rotated by a ratchet wheel device 41, 42 positioned outside the housing 7. The ratchet wheel device rotates a shaft 6 having a second level wheel 61 adapted for rotation therewith and which frictionally engages the bevel wheel 62 on shaft 63. Alternatively, bevel gears may be used instead of the bevel wheels 61 and 62.

The ratchet wheel device consists of two ratchet wheels 41 and 42 connected together by a pin 43 and adapted for rotation with the shaft 6 as shown in FIG. 2. The ratchet wheel 42 has a full complement of teeth while the ratchet wheel 41 is lacking a full complement as can be seen by the gap 41' in FIG. 3. A pair of pawls 45 and 46 pivoted about the pin 44 are provided for engaging and rotating the ratchet wheels 41 and 42 respectively. The pin 44 is carried by a pawl lever 4 which is subjected to an oscillating movement by the thrusting bar 3 which is pivotally connected to pawl lever 4. The thrusting bar 3 is mounted eccentrically on the shaft 11 by means of pin 32 so that rotation of shaft 11 will cause the thrusting bar to oscillate. Oscillation of pawl lever 4 will cause the pawls 45 and 46 to engage the ratchet wheels 41 and 42 and thereby cause their rotation. Means are provided, however, to prevent rotation of the ratchet wheels 41 and 42 even though the pawl lever 4 oscillates. This means consists of a shield 47*a* carried on the end of a lever 47 which is movable to a position between the tip of the pawl 46 and the ratchet wheel 42 to prevent the pawl 46 from engaging ratchet wheel 42. The lever 47, which is carried by an adjusting ring 64 rotatably positioned on the shaft 6, is actuated by the rods 48 and 49. These rods 48 and 49 are in turn actuated during the knitting of the heel and toe pouches by a chain cam 5 or other cam device operable from the circular knitting machine.

During the knitting of the leg portion of the stocking, the control cam 1 will be located all the way to the left of shaft 11 so that the cam followers R will ride on the cylindrical portion A of the control cam 1. Rotation of cam 1 in this position will not effect movement of the crank bell levers 8. Also, during the knitting of the leg portion, the shield 47*a* will prevent the pawl 46 from engaging the ratchet wheel 42 while at the same time the pawl 45 will oscillate back and forth in the gap 41' of ratchet wheel 41 so that both ratchet wheels will not rotate.

As the knitting of the heel pouch is about to begin, the cam 5 trips the levers 49, 48 and 47 to move the shield 47*a* to the position shown in FIG. 1 to allow the pawl 46 to engage the ratchet wheel 42 and thereby cause its rotation. After the pawl 46 commences to rotate ratchet wheel 42, the shield 47*a* moves automatically to the position shown in FIG. 3 and in this position prevents the pawl 46 from further engaging the ratchet wheel 42. However, since ratchet wheels 41 and 42 are connected together by the pin 44, the commencement of rotation of ratchet wheel 41 will move the gap 41' away from underneath the tip of pawl 45 so that pawl 45 becomes operable to engage and rotate the ratchet wheel 41 one full revolution in steplike fashion until the gap 41' once again reaches the pawl 45 at which time rotation of ratchet wheel 41 stops. During the one revolution of the ratchet wheels 41 and 42, the crank wheel 14 will execute one half of a revolution so that the cam 1 will be moved from its extreme left hand position to its extreme right hand position, as shown in FIG. 2. At this extreme right hand position the cam followers R will be on the raised portion B of the cam surface 2.

As will be noted from the drawings, the cam surface 2 does not extend completely around the periphery of the cam 1. FIG. 7 shows an elevation of the development of the cam in which the distance *t* represents the maximum rise of the cam surface 2 from its base and also the longitudinal movement of the stitch cams I, II, III and IV within the openings 91 in the cam ring 9. The distance *b'* corresponds to the cylindrical sector *b* (see FIG. 4) on which the heel pouch is knitted.

FIG. 8 shows a plan view of the development of cam surface 2 in which the cam width *h'* corresponds to the longitudinal height of the heel pouch in which the size of the loops varies.

The cam 1 is a three dimensional cam because it presents a varying contour to the cam followers as the cam 1 is moved longitudinally on the shaft 11. Longitudinal movement of the cam 1 on the shaft 11 will cause the cam followers R to ride up gradually on the cam surface 2. In so doing, the size of the loops will gradually increase along a longitudinal distance on the stocking corresponding to the cam width *h'*. The loops will also increase in size along an increasing circumferential distance, i.e. along an increasing segment of the path of rotation of

the cylinder so that the magnitude of the segment gradually increases during knitting of successive courses, until the full heel width *b* is made at which time the cam followers will engage the cam **2** at the fullest depth *t*. Knitting will occur at this portion of the control cam until the control cam is moved longitudinally in an opposite direction to gradually decrease the size of the loops in a similar manner along a longitudinal and circumferential direction. Because of the shallow rise *t* of cam surface **2**, the point or line where the size of the loops begins to increase will not be visible on the stocking. In FIG. 11, which shows a heel pouch produced according to this invention, it can be seen that the size of the loops of the successive courses of knit loops gradually increases and decreases in a longitudinal or vertical direction *Ms* and that the knit loops of each course gradually increase and decrease in a circumferential or horizontal direction *Mr*. Thus by producing the group of larger loops as shown in FIG. 11, a pouch is formed at a specific area of the knitted tube which is suitable as a heel pouch for a stocking. The toe pouch may be formed in a similar manner by gradually decreasing the size of the loops.

The cam shown in the drawing (FIG. 1 and FIG. 2) is of a kind having a plurality of cam surfaces differing in contour, wherein the number of cam surfaces is infinite, i.e. the cam surfaces are disposed axially along the cam **1** and in the embodiment illustrated the cam surfaces are all part of one continuous surface. The cam is movable axially. Thus, means are provided for changing the relative position between the cam and the cam follower to change the cam surface in operative relation with the cam follower.

Depending on the shape of the heel desired, the cam rollers R may remain in the right hand position B at which position the greatest heel width is knitted. In order to cause the knitting machine to return to making normal size loops, the chain cam **5** will actuate the levers **49**, **48** and **47** to move the shield **47***a* to allow the pawl **46** to engage the ratchet wheel **42**. When this occurs, the same sequence of operation of the ratchet wheels occurs as described previously. However, in this case the cam **1** will move in a longitudinal direction opposite to what it did previously because the crank wheel **14** will rotate on the second half of a revolution to return to its original position. In this way the loops in the heel pouch are progressively made smaller in a longitudinal and transverse direction to attain a gradual transition to the normal size loop used in the foot portion of the stocking.

With this invention it is possible to produce a knitted tube having pounches shaped to form perfect or near perfect heel and toe portions. The circular knitting machine used to accomplish this may employ one or any number of yarn feeds without reciprocating movement of the needle cylinder and independently of the use of a reinforcement yarn. The heel and toe pouches are made of larger loops using more yarn material and without unduly stretching the yarn as in the case of prior art practices where the heel is shaped in a plasticized condition. With the present invention it is possible to double the size of the loops in the heel and toe pouches without producing visible demarcation lines between the pouches and the rest of the stocking. Also the use of pattern jacks to change the shape of the heel and toe pouches is not necessary since it is possible to change the number of teeth on the ratchet wheel **41** or to change the position or shape of cam surface **2** to produce any desired pouch shape.

What is claimed is:

1. A circular knitting machine, comprising a needle cylinder, drive means for the cylinder, needles about said cylinder, a needle actuating cam, a control cam having a plurality of cam surfaces differing in contour, cam follower means operable off of the respective cam surfaces of said control cam to change the position of said needle actuating cam for varying the size of the knit loops over a segment of the path of rotation of the cylinder for knitting pouches, and means for changing the relative position between said control cam and said cam follower means to change the cam surface in operative relation with the cam follower.

2. A circular knitting machine according to claim **1**, a cylindrical cam body, said control cam being mounted on the cam body and varying gradually in contour circumferentially and axially of the cam body providing an infinite number of said cam surfaces.

3. A circular knitting machine according to claim **1** wherein the said means for changing said relative position between the control cam and cam follower means is operable to displace the control cam relative to said cam follower means.

4. A circular knitting machine according to claim **1**, said control cam being operatively associated with the means for rotating the cylinder and comprising a cam body and a contoured cam member detachably mounted to said cam body.

5. A circular knitting machine according to claim **4** including means for adjusting the position of said cam member on said cam body.

6. A circular knitting machine, comprising a needle cylinder, means for rotating said cylinder, needles on said cylinder, a needle actuating cam, a three dimensional cam operable to change the position of said needle actuating cam during rotation of the cylinder, a shaft upon which said three dimensional cam is slidably mounted, means operable from said shaft to change the axial position of said three dimensional cam on said shaft, and a control device for controlling the operation of the last said means.

7. A circular knitting machine according to claim **6** in which said control device includes a cam actuated member operable to initiate axial movement of said rotary cam.

8. A circular knitting machine according to claim **7** wherein said control device is operable at the time of commencement of knitting of the heel and toe pouches.

9. A circular knitting machine, comprising a needle cylinder, needles on said cylinder, a needle actuating cam, a cam shaft, a rotary cam operable on said cam shaft to change the position of said needle actuating cam, means responsive to rotary movement to change the longitudinal position of said rotary cam on said cam shaft, a rotatable ratchet wheel adapted to actuate said means, a pawl adapted to rotate said ratchet wheel, said pawl being operated by a link member eccentrically connected to the cam shaft, means to prevent said pawl from engaging said ratchet wheel, and means operable to initiate rotation of said ratchet wheel.

10. A circular knitting machine according to claim **9** including a second ratchet wheel adapted for rotation with said first ratchet wheel, a second pawl operable to rotate said second ratchet wheel, said second ratchet wheel having less than a full complement of ratchet teeth at its periphery to stop further rotation by second second pawl after one revolution.

11. A circular knitting machine for producing circular fabric of successive courses, comprising a rotary needle cylinder, a circle of independent needles around said cylinder, at least one stitch cam for actuating said needles and means for changing the position of said stitch cam over a segment of the path of rotation of the cylinder and means for varying the magnitude of said segment during knitting of successive courses to form pouches by continuous one way rotary knitting.

12. A circular knitting machine for knitting tubular goods by knitting a series of courses, comprising a needle cylinder, needles operable about said cylinder, drive means for rotating said cylinder, at least one needle actuating cam, and means for changing the position of said needle

actuating cam, during rotation of the cylinder and in synchronism with the rotation thereof, over a segment of the path of rotation of the cylinder, and means for varying the magnitude of said segment during knitting of succesive courses, to knit pouches in the tubular goods.

13. A circular knitting machine according to claim 12, said means for changing the position of the needle actuating cam being for gradually changing the needle cam position for gradually changing the knit loop size over each of said segments.

14. A circular knitting machine for knitting tubular goods by the knitting of successive courses, comprising a needle cylinder, drive means for rotating said cylinder, needles about said cylinder, needle actuating cams positioned about said cylinder, a control cam, a plurality of means operable off of said control cam to change the position of said needle actuating cams over a segment of the path of rotation of the cylinder and means for varying the magnitude of said segment during knitting of successive courses to knit pouches in the tubular goods, said plurality of means operable off of the control cam being positioned about said control cam in the same angular relationship as are the actuating cams positioned about the needle cylinder.

15. A circular knitting machine for knitting tubular goods by knitting a series of courses, comprising a needle cylinder, needles operable about said cylinder, drive means for rotating said cylinder, at least one needle actuating cam, and means for changing the position of said needle actuating cam, during rotation of the cylinder and in synchronism with the rotation thereof, over a segment of the path of rotation of the cylinder and means for varying the magnitude of said segment during knitting of successive courses and means for varying the size of longitudinally aligned knit loops during the knitting of successive courses to knit pouches in the tubular goods.

16. A circular knitting machine according to claim 15, said means for changing the position of the needle actuating cam being for gradually changing the needle cam position for gradually changing the knit loop size over each of said segments.

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